

**Marshall Space Flight Center (MSFC) EMI Test Facility (METF)**  
**EUT Test Questionnaire**  
**6/10/03**

Please complete this Equipment Under Test (EUT) questionnaire along with the MSFC Form 4404 (EMI Customer Agreement Form). EMI test coordination must begin with or (preferably) prior to Form 4404 submission. Failure to coordinate all test details and satisfactorily resolve test issues in a timely manner prior to the scheduled test start date will result in a delayed test start date and program schedule impacts.

**EMI Test Technical Issues**

1. The Equipment Under Test (EUT) EMI test requirements and procedures must be determined as one of the first EMI test planning steps. METF can provide assistance, if requested, in determining the EUT test requirements.
  - a. What is the EUT EMI test requirement (emission and susceptibility limits)? (e.g. SSP52000-IDD-ERP (EXPRESS Rack), SSP30237 (ISS), NSTS21000-IDD-MDK (Shuttle middeck), MSFC-RQMT-2888 (MSG), MIL-STD-461, SPACEHAB, etc.)
  - b. What EUT EMI test procedure to be used? (e.g. SSP52000-PVP-ERP (EXPRESS Rack), SSP30238 (ISS), MSFC-RQMT-521B (Shuttle, Shuttle middeck, SPACEHAB, MSFC-RQMT-2888 (MSG), MIL-STD-462, etc.)
  - c. Which revision of the requirement and procedure documents applies to the EUT?
2. What are the EUT power requirements? METF can supply 28Vdc and 120Vdc inside the EMI test chamber. List the individual EUT power requirements by bus voltage, maximum bus current draw, average/typical bus current draw, and the fuse level required on each bus. Also list any additional/special power requirements.

	Bus 1	Bus 2	Bus 3	Bus 4	Bus 5
Voltage (Volts)					
Maximum current draw (Amps)					
Average/typical current draw (Amps)					
Fuse level required (Amps)					

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3. What are the EUT operating mode(s) for each EMI subtest? In general, the worst-case modes for maximum emissions/maximum susceptibility need to be tested. Since this is usually unknown prior to test start, in general it is best to operate the EUT with as much equipment/subassemblies running simultaneously as possible. Considerations for maximum emissions include modes that cause maximum EUT prime power current, result in the greatest activity in interface circuit operation, and generate the largest current drain on internal digital clock signals. Any EUT modes that are considered mission critical in flight should be evaluated during susceptibility testing. All electrical interfaces should be exercised frequently to cause constant bus traffic flow for both emissions and susceptibility testing.
  - a. Specify the EUT operating mode(s) for each EMI emission and susceptibility testing. The rationale for testing the chosen mode(s) should be documented in the EUT EMI test plan.
  - b. What is the time required to complete one cycle of each mode?
  - c. What is the time required to switch between modes?
  - d. How long can the EUT operate in each mode?
4. Is the EUT a stand-alone unit or will any Ground Support Equipment (GSE) be connected to the EUT?
  - a. Will the GSE be located inside or outside the EMI test chamber?
  - b. What will be connected between the GSE and EUT (data/signal cabling, cooling lines, etc.)?
  - c. What are the GSE power requirements (voltage, current)?
5. If GSE will be located inside the test chamber with the EUT, is the GSE considered part of the EUT for EMI test purposes (especially radiated emissions and radiated susceptibility)? How will GSE emissions/susceptibility be differentiated from the EUT emissions/susceptibility?
6. How long are the connections/cabling between the EUT and GSE that will be used for the EMI test? Connections between the EUT located inside the test chamber and the GSE located outside the test chamber need to be a minimum 25 ft length.

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7. Electrical cable assemblies used for EMI testing shall simulate actual flight installation and usage. Shielded cables or shielded leads (including power leads and wire grounds) within cables shall be used only if they have been specified in the flight cable configuration. EMI test cables should be checked against flight installation requirements to verify proper construction techniques such as the use of twisted pairs, shielding, and shield terminations.
  - a. Are flight cables available for the EMI test?
  - b. How long are the flight cables?
  - c. If non-flight cables will be used to complete the GSE-EUT connection outside the test chamber, are these cables shielded and is the outer shield braid exposed so that the overall cable shield can be bonded to the test chamber stuffing tube to suppress external noise from entering the test chamber?
8. Flight power cables should be used for the EMI test when possible. Normally flight power cables between the EUT and the NASA power source are unshielded.
  - a. Will flight or non-flight power cables be used for the EMI test?
  - b. If non-flight power cables are to be used, the cable shielding configuration should match the flight cable configuration (if flight cables are unshielded then the test cables should be unshielded and if the flight cables are shielded then the test cables should be shielded).
  - c. What is the power cable length? The required cable length for EMI testing is 2-3 meters.
  - d. The connector on the power supply end of the EUT power cable must be coordinated with METF prior to the test start (male banana jacks are preferable).
9. If CS02 and CS06 testing are to be performed, the test power cables need to have a breakout within 5 cm of power entry into the EUT to enable EMI test injection equipment to be connected. The preferred breakout connections are female banana jacks.
10. How does the EUT achieve its flight bonding configuration (bond strap, surface mating, etc.)?
11. How will the EUT be bonded to the EMI copper-top test table to achieve the requisite 2.5 milliOhm EMI bond requirement?

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12. (Applicable only to NASA payloads) Is the EUT an “insert” payload (i.e. the EUT is inserted into a locker to facilitate mounting to the experiment carrier (EXRESS Rack, MSG, Middeck locker, etc.) and is not electrically bonded to the locker) or is the EUT chassis bonded to the locker? Is there provision to provide a chassis bond to the locker if the EUT fails EMI?
13. EUT performance must be monitored during susceptibility testing.
- a. How will EUT performance be monitored during susceptibility tests (GSE computer, EUT front panel indicators, etc)?
  - b. What constitutes an EUT failure during susceptibility testing (i.e. what EUT indicators will be monitored and what is the out of tolerance condition that constitutes failure)?
  - c. The EUT failure criteria should be included in the EUT EMI test plan.
14. What EUT support will be provided (personnel, equipment) to operate the EUT (and GSE as applicable) and ensure correct setup/operation? This is especially critical for development/troubleshooting testing.
15. The EUT hardware and software should be representative of the flight configuration. It is important that the hardware and software being tested is the same as the equipment that will be flown. Sometimes pre-flight equipment is tested that contains circuit boards that do not include the final layout and/or software that is not the final version. Qualification/verification questions inevitably arise concerning the effects of the differences between the tested equipment and the flight equipment configuration. Analytically determining the impact is usually difficult or impossible.
- a. What is the functionality of the system that will be tested, as opposed to the flight hardware? (e.g. are some flight functions not implemented on the EMI test article, is software still under development, are circuit board changes anticipated, etc.).
  - b. What modifications (hardware, software, cabling, etc.) will be made after the completion of EMI testing and before the hardware turn-over for flight?
  - c. A version/build description of the hardware, software, and cabling to be tested must be provided to METF on or before the first day of testing.

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16. The system brought for test should be thoroughly tested functionally prior to the hardware being delivered to METF to ensure that the system meets all EUT operational specifications. Delivering hardware and software that is just coming out of fabrication and has not been through integrated functional testing can impact tight program test schedules if the system is set up in the EMI facility and does not operate correctly.
- a. Has integrated functional testing been performed on the entire system and is the entire EUT system operating correctly (not just parts of the system checked separately)?
  - b. How much runtime is on the EUT system?
  - c. Are minor known problems/bugs with the hardware and/or software documented, so that these will not be attributed to EMI susceptibility effects?
17. If the EUT has undergone previous EMI testing (development or qualification) it is important to review previous test results to avoid any test setup/operation problems experienced during the previous testing.
- a. What previous EMI test data exists on the EUT? What was the EMI test specification?
  - b. Did the EUT pass or fail previous EMI testing? Please provide a summary table of EMI subtests performed and pass/fail for each.
  - c. What EUT hardware/software changes have been made since the previous EMI testing was performed? Were these changes in response to EMI emissions or susceptibilities noted during the previous EMI testing?
  - d. Provide details of the previous EMI test setup, especially noting any problems setting up the test or operating EUT and GSE hardware/software. At the minimum this will include a block diagram of the test configuration showing which equipment was inside the test chamber, which equipment was outside the test chamber, how all pieces of equipment were cabled together, and how cables passing out of the test chamber were configured.
  - e. Are special EUT test cables, GSE, etc. used in the previous EMI test still available and has this equipment been checked out with the modified EUT system being brought for the current test?

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18. The EUT EMI test plan/procedure should be supplied to METF for review at least 30 days prior to the scheduled test start date. A sample EMI test plan/procedure will be supplied upon request. Failure to supply a test procedure with adequate review time may result in a delayed test start date until all issues have been satisfactorily resolved.
  
19. A Test Readiness Review (TRR) should be held at least one week prior to the scheduled test start date to ensure that all test issues have been satisfactorily resolved. Failure to coordinate all test issues with METF personnel may result in a delayed test start date until all issues have been satisfactorily resolved.

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**General Technical Issues**

1. A general NASA requirement for electrical equipment is that the power leads be isolated from the EUT chassis by greater than or equal to 1 megaOhm.
  - a. Are the EUT electrical power leads required to be isolated from the EUT chassis?
  - b. Has the EUT power lead isolation from chassis been checked?
  - c. If applicable, the power lead isolation will be checked at METF prior to the start of EMI testing as part of the test setup.
2. Has EUT current draw on each set of power leads been checked, and are the positive lead and return lead currents equal on a given power feed? (Note: unequal currents typically indicate that the EUT is returning current through the chassis/ground plane, which is generally a violation of NASA electrical requirements). This will be checked at METF prior to the start of EMI testing as part of the test setup.
3. A general NASA requirement for electrical equipment is that a safety ("green wire") be included in the equipment's power cable.
  - a. Is the EUT required to have a chassis ("green" or "safety") wire in the power cable?
  - b. Is the chassis wire installed in the EUT test power cable(s)?

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**Programmatic Issues**

1. Are Marshall Space Flight Center (MSFC) Quality personnel required to witness the test? If so, the NASA test requestor must coordinate this support well in advance of the EMI test start date.
2. Does the EUT require an MSFC Customer Supplied Product (CSP) tag (a.k.a. "the blue tag")? If so, the NASA test requestor must complete the process to obtain the CSP. In general, if the EUT will be accompanied and operated by the customer at all times while on MSFC property during the EMI test, then a CSP tag is not required.
3. How will the EUT be delivered to MSFC (hand carry, overnight shipping, etc.)?
4. Special EUT handling requirements must be coordinated with METF well in advance of the test.
  - a. How much does the EUT weigh?
  - b. Can the EUT be safely lifted from the shipping container and placed on the EMI test table by two people?
  - c. What special handling methods are required?
5. The MSFC EMI test report will include a test summary, run log, any customer supplied test procedures/documentation, as-run METF facility operating procedure (FOP), test data, and test photos.
  - a. Do the EUT operators require any additional items for test documentation?
  - b. How soon after test completion is the EMI test report to be delivered (typical delivery times are 30-60 days)?



6. Normal METF operating hours are 8am-4:30 pm Monday-Friday. Are any special operating hours required to test this EUT?
7. The EUT part number(s) and serial number(s) must be supplied to METF prior to test start for inclusion in the test records/report.